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ISO 9001:2008 CERTIFIED CO.

INSTALLATION, COMMISSIONING,

OPERATION & MAINTENANCE

INSTRUCTIONS FOR

DISTRIBUTION TRANSFORMERS

[SMALL & MEDIUM CAPACITY]

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1.0 INTRODUCTION

1.1 GENERAL

1.1.1 SDTL make transformers are designed manufactured and tested to high standard of practice and are reputed for their quality and reliability in service. With proper installation, commissioning, protection and timely maintenance during operation, the users should receive from it the service which they may reasonably expect.

1.1.2 The purpose of this Instruction Manual is to provide guidance on the installation, commissioning and maintenance of oil-filled transformers. This guide is necessarily general in nature. In the event of any doubt, query arises or need for any further information or any irregularity / deviation from IEC / BS / IS / Equivalent Standard, observed, please refer to the manufacturer for clarification and possible assistance.

1.1.3 The transformer along with all its accessories / fittings should be installed, commissioned, operated and maintained under the supervision of a competent electrical engineer in accordance with relevant statuary requirements and good engineering practices, including Code of Practice, where applicable, and properly used within the terms of specification.

1.1.4 For the Domestic/International Standards & Codes of Practice, reference should also be made to the current edition / publication of IS / IEC / BS / Equivalent standards.

1.1.5 A list of Standards & Codes of Practice for selection, construction, application and operation of various transformers will be furnished on request to suppliers.

1.2 CAUTION

1.2.1 No transformer should have rated service voltage applied to it until ALL preliminary work and pre- commissioning tests and checks have been satisfactorily completed.

1.2.2 No high voltage tests should be applied to any transformer without making reference to the manufacturer.

1.2.3 A transformer which has been removed/stored from service for a long period of time should be rechecked prior to re-energising and placing the transformer back into service.

1.3 HEALTH AND SAFETY

1.3.1 Materials or components that are liable to be exposed or handled in normal operation & maintenance and which present any hazard to health are covered here under.

1.3.2 **Important**: 'Flash Test on Winding' is not recommended and if for any reason further testing is required at site, then it must be performed at reduced voltages only, which is value calculated by subtracting the service voltage from the original test voltage as tested as per the manufacturer's test certificate, having the obtained value and then adding the service voltage as explained in the example below;

Test Voltage as per Test Report	28kV
Service Voltage	11 kV
Half of Difference Voltage	17 / 2 = 8.5kV
Recommended Test Voltage at site	8.5 + 11 = 19.5kV

1.3.3 During design of an electrical distribution system including a transformer, care shall be taken with the following aspects;

a) selection of transformer installation site having adequate ventilation, normal operating temperature, protection against fire, moisture, explosion, etc.

b) selection of electrical protection at both primary & secondary side against over-load, short-circuit, earth-fault, etc.

c) provision for regular inspection & maintenance

1.3.4 In addition to the instruction given in this manual, IS / BS / IEC / equivalent standards and local regulation should also be referred for other details regarding the design, materials and performance

1.3.5 Excessive and prolonged skin contact with transformer oil (mineral oil) should be avoided. For further information regarding oil handling, please refer respective guidelines 'Effect of Mineral Oil on the Skin' & 'Cancer of the skin caused by oil.

1.3.6 A list of standards applicable to distribution transformer is given as below;

a) Distribution & Power Transformer	IEC: 60076/IS: 2026
b) Bushings for alternating voltage above 1000V	IEC:223/IS:3347
c) Loading guide for oil immersed transformer	IEC:354
d) Transformer Oil (Standard Mineral Oil)	IEC 60296

13.7 ADDITIONAL INFORMATION / SUGGESTION WILL BE GIVEN ON REQUEST.

2.0 DISTRIBUTION TRANSFORMER

2.1 GENERAL

2.1.1 All products have been designed, tested and supplied as per the specification and standards quoted, order acknowledged and subsequent modification as approved.

2.1.2 Some accessories / fittings / components referred in this manual are supplied only when specified and may not be incorporated into all the transformers supplied.

2.1.3 As efforts are being constantly made to improve designs and service, the equipment supplied may differ in minor details from the data given herein.

2.1.4 For information about the transformer actually supplied, ALWAYS refer to the Drawings, Technical Specification Sheet, Manufacturer's Instruction / Product Catalogue of the Accessories / Fittings and such documents furnished with the hand-over documents.

2.1.5 As the title implies the transformer distributes the power to various circuits at low voltage, generally 433V. For an anticipated variation appearing in the primary side supply voltage, the secondary side supply voltage is maintained within prescribed limits by the use of an Off-Circuit Tap Selector (OCTS) mounted integrally within the transformer tank. OCTS is connected into the Primary Side / HV Side Voltage Variation Tappings. The OCTS should be operated ONLY when the transformer is `Off-Circuit' i.e. totally isolated from the power supply, otherwise there can be heavy arcing at tap connections which may cause a fire / explosion hazard.

2.1.6 Transformer tank is suitably designed to allow the safe lifting & transportation of the complete unit without over-straining the joints / clamps that are supporting the core & winding assembly, radiators, etc. and effectively sealed for any oil leakage.

2.1.7 All floor mounted transformers are provided with skid type under-base with pulling eyes or axle holes suitable for handling with roller bars. Wherever required, foundation / mounting holes are provided in the under-base.

2.1.8 All pole mounted transformers are provided with either hanger bracket suitable for pole mounting or base/channel with mounting holes suitable for platform mounting.

2.1.9 The tank, core, windings, associated structures and leads of transformers are constructed to withstand both the thermal and mechanical effects arising from a short-circuit at the output terminals of the unit. Normal construction consists of a three limb magnetic core assembly, with each phase comprising of separate HV and LV Coils properly insulated, suitably supported and clamped. The whole assembly / structure is totally immersed in an oil-filled, fabricated tank.

2.1.10 Input connection to the transformer is via customer supply. This could be either overhead line, terminating at outdoor bushings or HT Cables terminating at HV Cable Box. Output connection from the transformer is via customer supplied LT Cables connected at LV Cable Box, feeding the load of the connected power system.

2.1.11 A Marshalling Box, if required, is provided to marshal all the transformer auxiliary wiring for convenience of external connection.

2.1.12 In addition to the standard Fittings / Accessories, the other optional / additional items as required by customer's specification are provided. All the items are listed in the 'Technical Specification Sheet' furnished with the handing-over documents.

2.2 STANDARD FITTINGS

2.2.1 As per IS / BS / IEC standards the 'Standard Fittings' as listed below, are the minimum requirements for the safe & correct operation of a transformer.

a) Diagram & Rating Plate
b) Off-Circuit Tapping Selector (when required)
c) Oil Level Indicator
d) Oil Drain Valve
e) Bushings: (i) Porcelain/Epoxy Bushings or (ii) Plug-in Bushings (as per requirement)
f) Earthing Terminals
g) Lifting Lugs
h) Jacking Pad (ratings above 2500 KVA)
i) Thermometer Pocket
j) Air-Vent for ratings above 2500kVA
k) Breather Pipe with Dehydrating Breather for ratings above 2500kVA
1) Conservator for ratings 11kV & 2500kVA - as specified by customer specification.

23 OPTIONAL FITTINGS

2.3.1 As per customer's specification, the Optional Fittings as listed below are provided for the additional protection operation of a transformer.

a) Oil Temperature Indicator
b) Winding Temperature Indicator with WTI CT
c) Gas & Liquid Operated (Buchholz) Relay
d) Explosion Vent / Pressure Relief Device
e) Disconnecting Chamber
f) Oil Filter Valve
g) Rollers or wheels
h) De-hydrating Breather for rating below 2500kVA
i) Conservator for ratings below 11kV & 2500kVA
j) Marshalling box for all wiring

3.0 GENERAL INFORMATION

3.1 ARRANGEMENT FOR TRANSPORTATION

3.1.1 Each oil-filled transformer is thoroughly dried-out before dispatch. Oil, whether in the transformer tank or in separate drums, is thoroughly filtered, before dispatch.

3.1.2 Parts that are liable to be damaged in transit are removed and dispatched in separate cases along with the transformer. Accessories like radiators, bushings, explosion-vent, dehydrating breathers, buchholz relays, temperature indicators, pressure relief device, conservator, etc., will be removed before dispatch.(higher power ratings). Distribution transformers can be shipped complete in standard shipping container.

3.1.3 Weatherproof blanking plates are provided where necessary. Due to transport limitation and for convenience of storage/handling at site, if a unit can be dispatched completely assembled then the transformer is usually dispatched from the factory with oil covering the core & winding along with the balance oil in separate sealed drums and the other accessories / fittings in a separate packages.

3.1.4 The transport oil quantity and the parts removed for transport are generally indicated in the G. A. Drawing or the Packing List furnished along with the unit during delivery / handing-over of the equipment. Re-assembly of these parts should be carried out such that the tank is opened to the atmosphere for a minimum time.

3.2 RECOMMENDED INSPECTION

3.2.1 Transformers are properly packed & dispatched by suitable transport up to destination. In spite of all care being taken during dispatch, the equipment can get damaged during transit. All consignment should be checked after delivery at site.

3.2.2 Immediately on arrival at site, any transformer should be examined for any sign of external damage in transit with particular attention to;

- dents / cracks in tank side-walls, covers, radiators, etc.
- damage to protruding fitting such as bushings, valves, sight glasses etc.
- loose bolts / screws / clamps
- oil leakage, particularly along welded joints & gaskets

3.2.3 Unless there is reason to suspect internal damage, the tank cover should not be opened and no attempt to lift Core & Coils clear of tank should be made. Internal inspection should be carried out to the maximum possible extent only via inspection covers provided. (Not applicable for Hermetically Sealed Type)

3.3 **UNLOADING & HANDLING OF TRANSFORMER AT SITE**

3.3.1 The transformer should be unloaded by means of a crane or suitable lifting device of sufficient capacity (For weight details, please refer the Rating & Diagram Plate). Always use lifting mechanisms, crane, chain pulleys, etc. of adequate capacity. Use of any under capacity lifting mechanism or accessories could result in severe damage to the transformer, lifting equipment and possibly personnel involved in handling the transformer.

3.3.2 For lifting, suitable lugs are provided on the cover & on sides of tank. Lifting lugs on the sides of tank are for lifting the complete unit, whereas the lugs provided on the tank cover must only be used for lifting the cover.

3.3.3 Jacking pads are provided to lift the transformer with jacks. Jacks should NEVER be placed under any valves or radiators. Do not use low capacity lifting jacks.

3.3.4 Skid type under base channels are provided on the bottom of the transformer, having towing holes for pulling & mounting holes for foundation of transformer. For heavy transformers, the under base is equipped with rollers allowing the unit to be manoeuvred into final position and then anchored.

3.4 STORAGE

3.4.1 Accessories / Fittings dispatched separately from main consignment are usually packed in case/crate, although certain items like conservator are sometimes dispatched loose without packing. All items as received should be stored in a dry and covered place provided there are no signs of damage or rough handling.

3.4.2 If oil received in drums is not to be used immediately, the drums should be stored in a covered space where the temperature variation is minimum. If it is necessary to store the oil outside, adequate protection must be provided at all times. Drums should not stand on end but should be placed on their sides in semi horizontal (lying) position with the bottom tilting at 45° downwards.

3.4.3 After arrival at site, it is desirable to erect and commission the transformer with minimum delay. In case this is not possible, the transformer should be fitted with conservator, dehydrating breather, etc. and filled with oil. The condition of desiccant (enviro-gel) must be checked periodically, particularly during warm and wet periods.

3.4.4 Indoor type transformer must be protected from the weather. Outdoor units may be stored outside, in a warm area, if possible, protected from the prevailing weather.

3.4.5 Whenever possible, it is recommended that the transformer is energised even at a low voltage so that the oil temperature is about 10° to 15°C higher than the surrounding ambient temperature.

3.4.6 Heaters for marshalling box, cable box, etc., should preferably be kept energised to avoid possible internal condensation / deterioration of the internal components.

4.0 INSTALLATION

4.1 PRECAUTIONS

4.1.1 Workmen accessing the interior of a transformer tank should empty their pockets of all loose articles. Any spanners or other tools used should be securely tied with a tape / thread and attached at tank top, so that they can be recovered, if accidentally dropped into the tank. (for Higher capacity voltage ratings of transformers)

4.1.2 Fibrous cleaning materials MUST not be used. The presence of loose fibre suspension, in insulating oil, can reduce its insulating properties. If any cleaning or wiping is necessary this must be done with clean and dry soft non-fluffy cloth only.

4.1.3 All accessories / fittings / components dispatched separately should be thoroughly cleaned inside and outside before being fitted. Rusted internal surfaces should receive special attention.

4.1.4 Insulating oil is inflammable and, under certain circumstances in a confined space, may become explosive. Naked lights & flames must NEVER be used adjacent to an oil filled transformer.

4.1.5 Air drawn into the transformer through semi-tight joints or along with the oil may be drawn into the windings thus reducing the insulation. To prevent this, all joints / covers in any extended oil pipe work must be air tight.

4.1.6 Insulating oil and the cellulose based solid insulation, normally used in transformer, absorbs moisture easily, particularly when cold. Condensation / 'damp' hazards can be caused if the interior of a tank is exposed to atmosphere. By taking adequate precautions this can be avoided / minimized, by circulating warm, dry de-aerated oil through it until its temperature is 5°C to 10°C above ambient. This should be done before allowing external access to the interior of the tank. The warm oil should be circulated all the time the transformer is open to atmosphere.

4.1.7 Under normal circumstances, it is NOT necessary to access the internal parts of the tank. Also, all the required tools / tackles / instruments are generally not available at site for the proper handling I access.

4.2 LOCATION AND SITE PREPARATION

4.2.1 No special foundation is necessary to install a transformer except a levelled floor base of sufficient strength to support the weight and prevent accumulation of water.

4.2.2 A foundation including special oil drainage/rain water collection facilities in case of fire and emergency is strongly recommended for large transformers.

4.2.3 The transformer should be positioned on the foundation so that easy access is available all around to access the diagram plates, thermometers, valves, oil gauges, etc., to be easily reached or read.

4.2.4 Adequate electrical clearances are also to be provided from various exposed live parts of the unit to any earth point. (Ref.: Statutory & Regulatory Requirement on Electrical Clearance in Air.)

4.2.5 Any transformer should always be separated from other transformer, reactors and any other such heat generating equipment. Transformer should be well placed sufficiently away from all walls / partitions to permit free circulation of air / ventilation all around.

4.2.6 Rollers, if fitted, shall be suitably clamped / locked to prevent any movement of transformer from its designated position in relation with HV / LV Side terminations.

4.2.7 External power conductors, power cables, control cables, earthing conductors, etc., shall be so positioned / supported such that no pressure is exerted on the transformer bushing terminals / cable box.

4.2.8 Naturally cooled transformers depend entirely upon the circulation of air to dissipate all heat generated due to internal losses. For indoor installation, therefore, the room must be well ventilated so that heated air can escape and be replaced by fresh cool air. Air inlets/outlets should be sufficient to allow adequate air to cool the unit. The inlets shall be near the floor and outlets shall be near the ceiling. If necessary, exhaust fans can be installed to assist the process.

4.2.9 If rollers are not fitted, a level concrete plinth with bearing plates / mounting channels of sufficient size/strength can be used for outdoor transformers. To prevent rust formation, it is essential to avoid air/water between plinth and the transformer base. If required, bitumen or such similar substance shall be used on the transformer base for weather-proof protection.

4.2.10 For small capacity pole mounted type transformer, proper care must be taken that all the supporting poles / structures, mounting brackets / clamps are of suitable materials & strength to bear both the static & dynamic weight of the transformer.

4.2.11 Suitable provision shall be made for all non-current carrying metal parts used for the transformer support / base such that they can be earthed, preferably at two points.

4.3 INSULATING OIL

4.3.1 Oil acts as both insulant & coolant. Cooling radiators fitted with the tank will be either fixed type or detachable type radiators for ONAN (Oil Natural Air Natural) cooling.

4.3.2 Only the insulating oil supplied along with the transformer shall be used for filling-up or topping-up the transformers. Any other oil not supplied by PDT shall be specifically approved by PDT to ensure that the original specification is maintained. THE MIXING OF OILS FROM DIFFERENT SUPPLIERS IS NOT RECOMMENDED REFER 4.3.3.

4.3.3 Oil from different sources may not completely mix together and may remain separated in layers. There may be a greater tendency to form acidity or sludge in a mixture of oil from two different sources than in a mixture of oils from a single source.

4.3.4 Oil supplied with the transformer is a pure hydro-carbon mineral oil conforming to relevant IS / IEC / BS standards for insulating oil. When exposed, oil can be easily contaminated. It is very important to keep the oil free from contamination, moisture, etc. All equipments / apparatus to be used for handling the oil should be first cleaned and flushed with clean insulating oil. Particular attention must be paid to cleanliness of bungs / plugs / stopper, valves and other such places, where dirt or moisture tends to collect.

Note:
(CONTAMINATED / USED OIL MUST BE DISPOSED ONLY IN ACCORDANCE WITH THE ENVIRONMENTAL REGULATIONS)

4.3.5 Oil must NOT be emptied / spilled / handled near naked lights or flame - the oil vapour released is inflammable.

4.3.6 Small quantities of moisture (particularly with presence of fibres or dust) lower the dielectric strength of the oil. Oil containers taken into a warm room / area must not be opened until the entire body has attained the same room temperature. This will reduce risk of condensation / moisture entering the oil.

4.3.7 For sampling, glass containers with glass stoppers are to be preferred over the metal types which are susceptible to contamination by dirt, etc. Wax should not be used for sealing the oil sample bottles. However, the stopper can be covered by a pack of dehydrating gel tied in a piece of cloth.

4.3.8 Flexible steel hose is best for handling insulating oil, some kinds of synthetic rubber or PVC hoses are also suitable but only those known to be satisfactory shall be used. Ordinary rubber hose should NOT be used - oil dissolves the sulphur from the rubber and is thereby contaminated. Any hose used for handling oil must be clean and entirely free from loose rust or other dirt. Cleanliness is essential as even small amounts of dirt and water will affect the accuracy of test results.

4.3.9 ALWAYS disconnect transformer from electricity supply before lowering the oil level.

4.3.10 In general, oil from a reliable source complying IEC:60296 / IEC:60422 / BS:148 / BS:5730 and, in addition, meeting the following requirements is approved to use.

- Break-Down Voltage (BDV) of the oil above 50 kV for 1 minute.
- Resistivity of the oil above 500x1012 ohm/cm at 27°C & above 13x 1012 ohm/cm at 90°C.
- Tan-Delta value of oil below 0.005 at 90°C.
- Moisture content of oil below 10 ppm

4.3.11 Samples of transformer oil, taken from the bottom of the tank / transported oil drum, when tested & found with a dielectric strength below 30kV (rms) during the one minute withstand time, in a standard test cell (13mm spheres 4mm apart) the matter must be reported to supplier along with insulation resistance values between various windings & earth. If the dielectric strength is between 40 & 50kV (rms), the oil should be treated to improve the dielectric strength.

4.3.12 Cloudiness of oil is due to suspended solid matter such iron oxide or sludge or moisture. The presence of moisture can be detected by 'Crackle Test', whereby when a red-hot iron pipe is immersed in the oil sample, crackle sound will be heard due to sudden evaporation of moisture inside the oil.

4.3.13 A petrol-like or acetylene odour may indicate a low flash-point due to prolonged high temperature because of an internal fault. A flash-point below 130°C indicates unsatisfactory condition and in that case necessary action shall be taken to assess the cause and take remedial steps or oil replacement.

4.3.14 Oil takes up moisture readily and its condition should always be checked before use. Oil of a muddy colouration is certain to be wet. Water and water saturated oil are both heavier than dry oil and sink to the bottom of any container. Oil samples should, therefore, be allowed to settle for 4 to 6 hours - in case of small transformer or drums, and for 10 to 12 hours - in case of large transformer. In general sampling, testing & treatment of oil shall be as per BS:5730-1979.

4.3.15 Samples from tank: Dirt adhering to the valve or plug is to be removed ensuring valve is VERY clean, and then a quantity of oil is allowed to flow into a separate container before collecting sample for testing. Samples should be collected in clear glass bottles, thus any water present in the oil will settle to the bottom and be clearly visible. Only use bottles with glass stoppers for sampling.

4.3.16 Samples from oil drum: Drum should first be kept standing vertically upwards for at least 24 hours. The bung area should be cleaned. A clean glass or brass tube long enough to reach to within 12 mm of the base of the drum should be inserted, keeping the upper end of the tube sealed with the thumb whilst doing so. The thumb should be removed, allowing oil to enter the bottom of the tube. The tube is then resealed and an oil sample withdrawn from the drum. The first two samples should be discarded. Further samples shall be collected in a clean bottle.

4.3.17 Testing: The oil after filtration should meet the requirements as laid down above. However, to establish the preliminary condition of the oil, the 'Break-Down Voltage' (BDV) Test shall be carried out as stipulated in IEC:60296 and results noted.

4.3.19 Before putting the oil into the tank, it should be tested and comply with specification as per IEC:60296 / clauses above. IF the oil does not meet the requirements, it should be processed and should be used ONLY when it meets the specification.

4.3.20 When filling it is preferable to pump the oil into the bottom of the tank and that an oil drying / filtering device is interposed between the oil pump and the tank reducing to a minimum any air entry into the tank with oil.

4.3.21 Used oils shall NEVER be mixed with the existing oil.

4.3.22 Oil shall be filled up to the marked level, indicated on the oil level gauge corresponding to the oil temperature at that time.

4.3.23 After the oil filling, ensure that all the air release plugs, petcocks and valves are tightly closed and that dehydrating breather is provided with oil seal.

4.3.24 Oil should be allowed to settle at least for 12 hours - in case of small transformer or for 24 hours - in case of large transformer. After which, again all air release plugs, petcocks and valves shall be open till the oil flows out, allowing the escape of any trapped air, after the oil has completely settled down.

4.4 GASKETS AND JOINTS

4.4.1 Transformer sealing gaskets are made of neoprene bonded or rubberized cork. When supplied loose, generally have no holes, however, in some cases, gaskets are supplied in pieces cut to size and shape as required as straight, angled, or U shaped pieces from which complete gaskets can be built.

4.4.2 When assembling / joining individual pieces use scarf joints only. Assembled portion should be located away from corners and bolt holes, and should be evenly bonded. `Holdite' solution is used as an adhesive for joints.

4.4.3 To make a gasket joint, first clean all metal surfaces ensuring freedom from oil, rust, scale, etc. Using one of the flanges as template, mark and punch the necessary bolt holes in each gasket. Insert and evenly tighten each bolt so that uniform pressure is exerted on the gasket until the gasket is compressed to approx. 2/3 of its original thickness. If proper care is taken - in making and handling joints or gaskets, it is possible to break / re-make a joint several times, using the same gasket.

4.4.4 Gaskets are best stored in hermetically sealed containers in a cool place. They must be protected from damp, oil and grease.

4.5 TERMINALS / BUSHINGS

4.5.1 Bushings are usually removed for transport and the bushing holes blanked off. Before fitting, bushings should be examined for damage or cracks which may have occurred during transit. They should be cleaned with a dry non-fibrous cloth.

4.5.2 Bushing should be assembled with their adapters, if supplied loose using the proper gaskets for the various joints. When clamping the bushings to the tank, care should be taken to ensure that an even pressure is obtained on the flange of the porcelain and its gasket by tightening the diagonally opposite nuts alternatively.

4.5.3 The external line termination / connection to all types of bushings should be flexible to ensure that there is no strain exerted on the bushings because of line movement such as swing, expansion, contraction etc.

4.5.4 If arcing horns are fitted, the gap shall be checked and adjusted as per the drawing.

4.6 CABLE BOXES (if applicable/supplied)

4.6.1 Compound filled cable box:

a) If cable boxes are supplied separately, they should be first fitted on the tank with the proper gasket joints. After making the suitable end-termination and connection with the terminal bushings, the box should be filled, up to the correct level, with suitable filling medium. Hot insulating compound shall not be poured directly on the porcelain of insulator. Before energising the transformer, the filling medium should be allowed to settle-down for 24 hours to check against possible leakage.
b) After the filling, the filling holes should be closed with weatherproof plug with copper fibrous gaskets / sealed with suitable grade of bituminous compound which will not crack during cooling (e.g. Grade Class-3 of BS:1858).
c) The cables should be supported separately to ensure that no-undue strain is exerted on the porcelain bushing terminals in the cable box.

4.6.2 Air filled cable box (for Heat-Shrink / Push-On / other such Termination):

a) Cables shall be terminated on copper bus-bars provided in a cable box and termination shall not exceed the number of holes provided. In other words NO extra holes may be made in bus-bars at site.
b) The cable shall be clamped / supported by suitable cable glands. Care shall be taken to ensure minimal stress on the bus-bar.
c) Necessary identification of phases is provided inside the cable box. After completion of termination, insulation tape can be applied on each bus-bar.

4.7 CONSERVATOR (If SUPPLIED)

4.7.1 As the temperature of insulating oil increases or decreases, there is a corresponding rise / fall in the oil volume. To allow for this, an expansion vessel (conservator) can be connected to the tank to limit the amount of air to be in contact with insulating oil.

4.7.2 While assembling the conservator, ensure that internal surface, all openings, pipe works, valves, etc, are clean & free from moisture and all gasket joints are oil-tight.

4.7.3 Prismatic / Plain hardened glass type oil gauge, if fitted with the conservator, is generally marked with calibrated level to show cold oil level at 30°C temperature.

4.8 DEHYDRATING BREATHER (If SUPPLIED)

4.8.1 Plain pipe breather is generally sealed with cap for transit purpose and the same should be removed ONLY during commissioning.

4.8.2 Alternatively, a Dehydrating Breather should be fitted to ensure that air entering the tank during breathing is dry thus preventing insulation loss of oil due to internal condensation.

4.8.3 A Dehydrating Breather, usually Envirogel (self indicating silica-gel) or Blue Silica-Gel, is dispatched as loose item to prevent unnecessary accumulation of moisture via two-way valve / oil-seal cup of the breather during transit.

4.8.4 In case of Envirogel, for visual indication of degree of saturation, the silica-gel is impregnated with suitable non-toxic dye. Envirogel in YELLOW / ORANGE colour, indicates the ACTIVE state or readiness to absorb moisture and when in GREEN colour, indicates the INACTIVE / saturated state or presence of moisture or inefficient to absorb further moisture.

4.8.5 In case of Blue Silica-Gel, for visual indication of degree of saturation, the silica-gel is impregnated with Cobalt Chloride [Class-2 Carcinogen]. When Silica-Gel is a BLUE colour, this indicates the ACTIVE state or readiness to absorb moisture and when it has become PINK it's unable to absorb further moisture.

4.8.6 To activate the saturated silica gel, heat it in a pan / oven at 120- 130°C temperature until the original colour is regained within 2 to 3 hours, otherwise always replace with new gel and discard the used gel.

4.8.7 When the oil-filled transformer is fitted with the de-hydrating breather ALWAYS reactivate / replace the desiccant once the colour indicates the saturated state, irrespective of whether the transformer is energised or not.

4.8.8 The plug sealing the top of the breather should be removed and connected to the associated pipe-work. The oil cap at the bottom of the breather should be removed, filled with insulating oil up to the mark and the cap replaced. The oil seal ensures that breather does not absorb moisture when the transformer is not breathing.

4.8.9 When refilling the desiccant, do not expose the same to the atmosphere for an undue length of time, otherwise it will start absorbing the moisture and thus impair its purpose. Also, after fixing the breather, ensure oil seal is filled with oil up to the mark.

4.9 EXPLOSION VENT / PRESSURE RELIEF DEVICE (IF SUPPLIED)

4.9.1 The explosion vent flange on the tank cover is blanked during dispatch. This should be removed and the explosion vent pipe fitted with suitable diaphragm and air-tight gasket joints. And the top blanking plate should not be removed till the oil level inside the transformer is above the tank cover.

4.9.2 For some transformers, the space above the oil in the explosion vent is usually connected by a pipe to the top of the conservator to equalize the pressure & vent it to the atmosphere through a breathing device.

4.9.3 For transformers supplied without such equalizing pipe, an air-cock is fitted at the top of the explosion vent pipe, which must be opened (to vent) when the tank is being filled with oil and then closed again.

4.9.4 If an over-pressure inside the tank causes failure of either / both diaphragms, renew the same immediately.

4.9.5 As an alternative a spring loaded device (Pressure Relief Device), which resets itself immediately on removal of overpressure, can be supplied. This may also be fitted with a mechanical indicator for visual indication to show operation.

4.9.6 A single set of contacts is provided for trip signal. These terminals are clearly marked for function and polarity (locked during shipment), which should be set at service position before energising the transformer. When making the connection from these terminals in conduits, ensure that no condensation can drain into the terminal box.

4.10 BUCHHOLZ RELAY (IF SUPPLIED)

4.10.1 The buchholz (gas / liquid operated) relay is connected in the pipe work between transformer tank and conservator. If a valve is fitted to isolate the conservator, the buchholz relay is usually on the transformer tank side of the valve.

4.10.2 Under normal condition the relay is full of oil. As generally known, most types of faults occurring within oil filled transformers are accompanied by the generation of gas by the oil due to liberation of heat. Such generated gas gets accumulated in the relay thereby operating the float / flap switches.

4.10.3 With an incipient fault, gas is produced at a very slow rate and the upper float (alarm) switch will operate after a specified volume of gas has collected. The upper float (alarm) switch will also indicate the low oil level of the conservator.

4.10.4 When a major fault occurs, the gas is produced rapidly resulting in sudden surge of oil up to the conservator thereby operating the lower float (trip) switch. The lower float (trip) switch will also indicate the drained oil level of the conservator.

4.10.5 To ensure successful operation of the relay, the pipe work on either side of the relay and the relay itself, are all set at the same angle (2°-5 ° to the horizontal for single float relay and 3°- 7° to the horizontal for double float relay). A machined surface is provided on the housing of the relay to check the level. And the arrow shown on the relay should point towards the conservator.

4.10.6 The alarm and trip terminals are clearly marked for function and polarity (locked during shipment), which should be set at service position before energising the transformer. After which check that the operating floats / flaps are free. When making the connection from these terminals in conduits, ensure that no condensation can drain into the terminal box.

4.10.7 In service, the top petcock should be kept closed. Before energising the transformer, all air which may have collected in the relay should be released through the petcock.

4.11 TEMPERATURE INDICATORS (IF SUPPLIED)

4.11.1 The Oil Temperature Indicator (OTI) and Winding Temperature Indicator (WTI) work on either the liquid expansion or bi-metallic principle and provide indication of top oil and average winding temperature via dial type indicators. In all cases, the indicators shall be mounted vertically for best accuracy of readings.

4.11.2 The thermometer bulb / probe is connected by capillary tube to the indicator. The bulb / probe shall be fitted into the thermometer pocket provided in the transformer main tank cover near the hottest oil region. Before fitting the bulb / probe, thermometer pockets should be part filled with transformer oil.

4.11.3 WTI is same as OTI except for the current feed circuit from CT to heating element either on the thermometer pocket or in the instrument itself.

4.11.4 Normally the current feed to WTI is provided from a CT at one phase of the LV winding. Such CT has suitable Ratio to feed required current to heat the heating element. This additional temperature component from heating element together with the prevailing top oil temperature gives the average winding temperature seen at WTI. The CT connection to WTI shall be made carefully (Ensure that CT secondary is not open circuit at any time).

4.11.5 The copper capillary tube is protected by flexible steel tubing, which is strong enough to withstand normal handling. It should NOT, however, be bent sharply or be twisted. To prevent sagging, tube shall be supported by clip along it entire length. And the excess length, if any, can be rolled spirally and on no account it should be cut.

4.11.6 OTI and WTI are provided with a re-settable maximum pointer and mercury float limit switches or bi-metallic switches for electrical alarm & trip indication, as specified by the customer.

4.11.7 OTI and WTI may also be provided with Thermistors, whose resistance varies with temperature, for temperature reading at temperature detector located at a remote panel.

4.11.8 Before installing the instruments, the accuracy can be checked by dipping the bulb I probe in a hot oil or water bath and checking the instrument readings against a standard calibrated thermometer. The indicator readings should be allowed to steady (inherent time lag) and the readings shall be accurate within 1°C.

4.11.9 If required, alarm / trip switches shall be adjusted to make contact at the set temperatures as per site conditions i.e. ambient temperature, loading conditions, etc.

4.12 COOLING RADIATOR

4.12.1 If shipped separately, all the radiators, pipe work and headers should be cleaned and flushed with clean dry oil before fitting. These should be assembled as shown on the Outline/G.A drawing.

4.12.2 During assembly care must be taken that all the gasket joints between radiator and the transformer tank are air-tight and the flanges are evenly fitted.

4.12.3 After assembly of radiators, the shut off valves provided at top & bottom should be opened. This will allow the radiators to be filled with clean and dry transformer oil. Air should be released from top of the header of each radiator.

4.12.4 For corrogated tanks the conditions does not apply as cooling part/radiator is an integral part of tank in form of corrugation.

4.13 CURRENT TRANSFORMERS (IF SUPPLIED)

4.13.1 Before energising the transformer, secondary circuit of any CT fitted MUST always be short-circuited or connected with the load circuit. When CT primary is energised with secondary winding open, excessive voltage will develop across the secondary circuit and damage the CT or become a safety hazard if touched.

4.14 EARTHING CONNECTION

4.14.1 The tank should be permanently and effectively connected to earth by means of flat / flexible conductor of suitable size & materials (galvanised steel / copper / equivalent) terminated on earthing terminals / pads provided at the bottom of the tank, cable box, marshalling box, switch gear box, etc.

4.14.2 Earthing connection(s) with a good low resistance is/are essential for adequate protection against electrical faults. All the earth connections should be of sufficient physical size to carry the line current for 30 seconds.

4.15 PAINTWORK

4.15.1 All metal parts are properly cleaned, suitably surface treated and given three coats of high quality paint before dispatch from the works. The first, which is applied to the neat metal surface, is a primary coat, followed by an intermediate coat and then a final finishing coat as per relevant specification.

4.15.2 Normally the final finishing coat will be dark grey, as per Colour Chart Shade Nos.of IS / IEC / BS, unless specified differently by the purchaser.

4.15.3 If the paint-work has been damaged during transit or erection, touch-up painting should be carried without delay to avoid any possible rusting of metal.

4.15.4 For exact detail of colour shade, refer general arrangement drawing or technical specification furnished with hand-over documents. If no information available, suitable paints shall be procured in consultation with product literature of any reliable paint suppliers.

4.15.6 For further guidance, the following information is provided;

a) Surface to be repainted should be thoroughly cleaned to remove any grease/rust.
b) Dry Film Thickness (DFT) shall be 25 to 35micron for the first coat, 50 to 60micron after the second coat and 75 to 80micron after the finishing coat. (May vary as per customer specification).
c) For normal environment, high quality alkyd resin based paint is recommended. And for polluted environment, paint as recommended by paint suppliers shall be used.

4.16 COMPLETION OF OTHER INSTALLATION WORKS

4.16.1 Any work such as secondary wiring from various Phase CT's / Neutral CT, wiring of various alarm / trip contacts from various accessories of the transformer to Marshalling Box, Control Gear Box, if/as required shall be completed at site.

4.16.2 All the scheme wiring, relay settings, functional checks, etc., should be completed before the transformer is released for commissioning into service.

4.16.3 For installation and fittings kindly refer to Drawing enclosed (Annexure-I)

5.0 COMMISSIONING

5.1 PURPOSE

5.1.1 After the satisfactory completion of installation, the following pre-commissioning checks and tests on instruments must be performed before putting the transformer into service. Prior to commissioning work, for specific help and information on the accessories supplied, refer to the manufacturer's instruction booklet / product catalogue, etc., furnished with the handing-over documents.

5.2 COMMISSIONING TESTS

5.2.1 Insulation Resistance (IR) Test:

a) Before starting this test all the power terminal bushings should be thoroughly cleaned with a dry clean piece of cloth.
b) During IR test, no external power lines / cables, lightning arresters, neutral earthing, etc., should be in the power circuit. And ensure that transformer is completely isolated at HV & LV sides and all non-current carrying conductors are earthed.
c) At all the tap positions, IR values of windings to earth & between windings shall be measured with designated insulation tester of suitable ratings and readings noted.

Between HV Winding and Earth (Megger)	use 5000V or 2500V Insulation Tester
Between HV and LV Winding (Megger)	use 5000V or 2500V Insulation Tester
Between LV Winding and Earth (Megger)	use 1000V or 500V Insulation Tester

d) IR values obtained should be similar to those indicated in the manufacturers' test report, furnished with the handing-over documents. In humid weather, IR values obtained may be lower due to condensation on the terminal bushings.
e) If IR values are very low and unacceptable, then it may be necessary to filter the oil / dry-out the winding till the insulation reaches satisfactory values.

5.2.2 Break-Down Voltage (BDV) Test:

a) Oil samples from tank bottom, tank top, radiator, etc. shall be carefully taken and tested for BDV value, as per clause 4.3 of this manual.
b) BDV value of oil should be more than 50kV(rms) for 1 minute in standard test cell.
c) If BDV value is very low and unacceptable (30kV(rms) or less for 1 minute, then it may be necessary to dry-out & clean the oil till the insulation reaches satisfactory values.

Note: For very low IR values and low BDV values, it is recommended to contact suppliers or manufacturer for suitable recovery procedure based on available facilities at site.

5.2.3 Voltage Ratio Test

a) Apply 3-Phase, Low voltage AC supply on the HV side and the Voltage Ratio at all tap positions can be derived using suitable precision voltmeter connected to the LV side. A ratio meter, if available can be used for a more accurate measurement.
b) The Ratio values obtained should be similar to those indicated in the manufacturers' test report, furnished with the handing-over documents.

5.2.4 Winding Resistance Measurement Test

a) Winding Resistance of every phase of each winding should be measured using suitable DC Resistive Bridge or similar.
b) Winding Resistance values obtained should be similar to those indicated in the manufacturers' test report, furnished with the handing-over documents.

5.2.5 Marshalling Box Scheme Check (if supplied)

a) All the auxiliary wiring from various accessories to marshalling box shall be checked with marshalling box scheme drawing furnished with the handing-over documents.
b) During testing of accessories like buchholz relay, etc., operation of all the alarm / trip contacts shall be checked at marshalling box terminal blocks ensuring both operation and wiring are checked correct.

5.2.6 Buchholz Relay Test (if supplied)

a) Relay operation for alarm and trip contact shall be checked by injecting air inside the relay through test petcock. Injected air collected inside the relay allow the alarm float / flap & trip float / flap to fall thereby operating their respective switch.

5.2.7 Temperature Indicator Test

a) Indicators operation for alarm and trip contact shall be checked by manual stimulation if available.

5.2.8 Off-Circuit Tap Selector (OCTS)

a) During shipment, the OCTS has not been separated from the transformer so it is not necessary to recheck the internal connections of tapping and internal mechanism.
b) Means of protecting the OCTS from unauthorised operation is provided by using pad locking arrangement at designated tap position.

5.3 SENSIBLE ADDITIONAL CHECKS

5.3.1 BEFORE SWITCH ON, ENSURE that

a) All the Oil Shut-Off Valves are OPEN and Draw-Off Valves are CLOSED.
b) All Thermometer Pockets are near filled (85%) with oil.
c) Oil is at correct level in the Bushings, Conservator, etc.
(In case of Nitrogen filled transformers, oil level on tank)

d) Desiccant colour in breather is blue for blue silica-gel or yellow /orange for envirogel.
e) Earthing Connection of Main Tank, Neutral Bushing, Marshalling Box, Control Gear Box, Cable Box, Arcing-Horn, etc., are correctly made.
f) Bushing arcing horn gap is set correctly.
g) All CT Secondary Circuits are closed.
h) All Air-Release Plugs of Main Tank, Radiator, Conservator, Buchholz Relay, Bushings, etc., are free of air pocket / bubbles.

Note: After Oil-Filling or Before Commissioning, AT LEAST 12hrs should be allowed for the oil to settle-down and air is released from all points at 2 hourly intervals.

5.3.2 It is recommended that the transformer is initially energised at NO-LOAD only and checked for any abnormalities for the next 6 to 8 hours.

53.3 AFTER SWITCHING on no-load, if the Primary Side Circuit Breaker is tripped, investigate the cause thoroughly and re-energise the transformer ONLY AFTER ensuring that the fault is properly cleared.

5.3.4 If satisfactory (transformer on No-Load) then apply load gradually and observe for any abnormalities for the next 6 to 8 hours.

53.5 If the transformer is satisfactory on-load up to 50% for the first 4-8 hours, shut-down the transformer and ensure that all air-release plugs of tank, radiator, conservator, buchholz relay, bushings, etc., are free of air pockets which might have developed during initial loading.

6.0 MAINTENANCE

6.1 General

6.1.1 If a transformer is to give long and trouble-free service, it should receive a reasonable amount of maintenance, which consists of regular inspection, testing and reconditioning when necessary. Records should be kept giving details of any abnormalities during service and also of any periodic test results taken. This demonstrates compliance with the general requirements of ISO:9000.

6.1.2 MAIN OBJECTIVE OF ANY MAINTENANCE IS TO PRESERVE THE ORIGINAL PROPERTIES OF THE MATERIALS IN GOOD CONDITION. Moisture, dirt, excessive heat / over-loading, mishandling, etc., are the main causes of INSULATION deterioration.

6.1.3 No maintenance work should be done on the transformer, unless all the external circuits are disconnected / made dead and that all the windings are solidly earthed.

6.2 INSULATING OIL

6.2.1 Oil is a VERY IMPORTANT liquid being used both as a coolant & dielectric (insulant) in the transformer and thus keeping the oil in good condition will prevent deterioration of the paper & other such solid insulation materials immersed in it.

6.2.2 IEC:60422 - 'Maintenance of Insulating Oil' gives recommendations in detail for the preservation of insulating oil. A few short notes on the subject are given as below;

a) Oil level should be checked at frequent intervals and any excessive leakage of oil must be investigated thoroughly. There may be a slight loss of oil by evaporation; this need not cause concern if the tank is topped up at regular intervals.
b) All minor leaks or sweating should be repaired as quickly as possible.
c) Oil shall be topped-up as per instruction of this manual. It is once again emphasized that any new oil to be added shall preferably be from the same source as the original oil. New oil from a different source may be added as make-up only but not exceeding about 10% of existing oil volume. In this case, suitable records should be kept.
d) Samples of oil should be tested at regular intervals and results are recorded.
e) Dielectric strength alone does not give a true indication of oil condition. If dry, even highly deteriorated oil can give a high dielectric strength.
f) Normal oil filtration method can maintain the dielectric strength only, but does not give indication of the deteriorated condition of the oil. It is NOT advisable to rely solely on the dielectric strength of the oil by periodic test, without verifying its chemical composition. Reconditioning by centrifugal separation or filtration does not remove the acidity from oil but will remove moisture, sludge, dust, dirt, etc. and will tend to retard the process of deterioration. Filtration with Fuller Earth will help to reduce acidity in oil and in addition improve the resistivity value of the oil.
g) If the dielectric strength is below 30kV(rms), the oil should be reconditioned by passing it through either a centrifugal separator or a filter. After

reconditioning, the dielectric strength should be such that oil can withstand a minimum of 40 kV(rms).

h) If acidity value is 0.5 to 1.0 mg KOH per gm of oil, it is recommended that the oil be kept under observation. If the acidity is increasing rapidly, or exceeds 1.0 mg KOH per gm of oil, the cover should be removed to ascertain the condition of the interior of the tank and of the core & windings. Oil is then be treated or discarded, if sludge or corrosion is evident. Advice should be obtained from the suppliers.

6.3 INTERNAL — TRANSFORMER CORE & WINDINGS

6.3.1 It is recommended that the core & windings only be removed from the tank for visual inspection if PARTICULARLY necessary.

6.3.2 Following draining all oil from the tank, internal inspection should be done via opened top cover or side inspection cover openings. DO NOT USE NAKED FLAME OR LIGHT but SAFETY LAMP for internal inspection.

6.3.3 Before lifting the core & windings from the tank it is necessary to disconnect the winding connections from terminal bushings inside the tank and the earthing connection between the core and the tank. The core and windings must be removed with great care, and when removed be stored under the proper cover and in a dry place.

6.3.4. Windings should be examined to ensure that no sludge has been deposited to block the oil ducts / opening passages.

6.3.5 OC Selector terminals shall be thoroughly cleaned and ensure no welds / dents exist at tapping contacts. And that all the tapping leads are properly insulated / supported without any loose sag. Also ensure smooth & full operation of OCTS.

6.3.6 Any loose nuts & bolts should be tightened and main clamping checked for tightness.

6.3.7 After completion of examination, CHECK to ensure no foreign items have been left inside the tank.

6.3.8 Alternative to this 'time consuming process', a regular DGA (Dissolved Gas Analysis) of oil will give effective indication of any potential problems beginning to occur. Also video camera technique can be used to carry out an internal inspection quickly and with minimum problems

6.4 EXTERNAL — OUTDOOR / INDOOR TERMINAL BUSHINGS

6.4.1 Outdoor Porcelain insulators/plugin busings and rain sheds should be cleaned at regular intervals. Metallic scrubber can be used effectively to remove dirt / stains.

6.4.2 During cleaning, the outdoor porcelain bushings should be examined for oil leakage, cracks or other defects and defective ones should be replaced.

6.4.3 Arcing horns, if fitted, shall be checked for any arcing dents / welds and correct gap setting. And any arcing horn with dents / welds are replaced or rectified.

6.4.4 Indoor Porcelain Insulators, usually placed inside the cable box, do not require cleaning under normal circumstances.

6.5 CABLE BOXES (if supplied)

6.5.1 In case of compound filled cable box, check regularly for leakage at weatherproof plugging / sealing with bituminous compound, which shall be free from any cracks.

6.5.2 In case of air-filled cable box (for Heat-Shrink / Push-On / other such dry termination), though no maintenance is required, it is advisable to check regularly for cleanliness, damages of bushings, tightness of termination, etc.

6.6 COOLING RADIATORS

6.6.1 Cooling Radiators should be checked for any oil leakages along all the welded joints, gasket joints, plugs, etc.

6.6.2 Any bend, dents, etc., should be rectified as soon as possible.

6.7 CONSERVATOR (if supplied)

6.7.1 Conservators are arranged so that the lower part acts as a sump in which any impurities entering the conservator will tend to collect. A valve is fitted at the lowest point of the conservator for draining and sampling. When sampling, care must be taken to run off any such sludge before taking oil sample for testing.

6.7.2 The inside of the conservator should be cleaned and a removable end is provided on each conservator for this purpose.

6.8 OIL GAUGES

6.8.1 Oil gauge should be kept clean and any damaged glasses should be replaced immediately. The gauges are normally fitted with strengthened plate glass which is unbreakable under normal service conditions.

6.9 DEHYDRATING BREATHER (if supplied)

6.9.1 The dehydrating breather should be regularly checked for colour of desiccant. When the majority of gel becomes saturated, the same shall be replaced or reactivated.

6.9.2 Oil in the oil seal, if used, should be maintained up to the level marked on the cup.

6.9.3 The frequency of inspection depends upon local climate and operating conditions. More frequent inspections are needed when the climate is humid and when the transformer is subject to fluctuating load.

6.10 BUCHHOLZ RELAY (if supplied)

6.10.1 The relay should be routinely inspected and the operation of relay is ensured by injecting air into the relay and check that floats are able to fall / rise freely and that the mercury / magnetic switches are making / breaking the contacts.

6.10.2 During service, if the relay is operated due to an accumulation of gas and not due to fall of conservator oil level. Any internal faults can be identified to a great extent by a chemical analysis of gas. Sometimes, on analyzing the gas, it may be noticed that the gas collected is only air. This may be that the oil is releasing any absorbed air during oil filtration or due to change in temperature.

6.11 EXPLOSION VENT OR PRESSURE RELIEF DEVICE (if supplied):

6.11.1 In an explosion vent, the diaphragm is fitted at the exposed end of the vent, which should be inspected at frequent intervals and replaced if found deteriorated / damaged. Failure to replace the defective diaphragm quickly may allow the ingress of moisture, which will contaminate the oil. If the diaphragm has broken due to an internal fault, a full inspection should be made to determine the nature and cause of the fault BEFORE re-energising the transformer.

6.11.2 In a spring loaded 'blow-off & self or manual reset' type Pressure Relief Device, if the indicator, usually an oil-slick or a flag is operated, then an inspection should be made to determine the cause of fault BEFORE re-energising the transformer.

6.12 TEMPERATURE INDICATORS

6.12.1 The level of oil in the thermometer pockets should be checked and the oil replenished, if required. The capillary tubing should be fastened down again if it has become loose. Dial-glasses of temperature indicators should be kept clean and, if broken, replaced. Temperature indicators if found to be reading incorrectly should be re-calibrated with standard thermometer immersed in hot oil bath.

6.13 SEALING GASKETS

6.13.1 Gaskets sometimes shrink during service. It is necessary to check the tightness of all bolts fitted with gaskets. The bolts should be tightened evenly around the joints to avoid uneven pressure. Damaged gaskets should be replaced as soon as possible.

6.14 BOLT, NUTS & FASTENERS

6.14.1 All bolts, nuts, fasteners, etc., shall be thoroughly checked for proper tightness and any deteriorated parts should be replaced.

6.15 PAINT-WORK

6.15.1 During storage and service, the paint-work should be inspected once a year, especially at the welded seams / joints, and where necessary, painting or retouching carried out. If the metal surface is exposed and becomes dirty, rusty or greasy because of delay in repairing the paint-work, the surface must be thoroughly cleaned with a wire-brush or similar abrasives, before repainting to ensure a good bond between

metal and paint. If paints recommended by supplier are not available, any good quality alkyd resin-based paint may be used.

6.16 VALVES

6.16.1 All valves should be checked for any leakage and for open / close operation. Blind caps should always be kept fitted on them.

General Notes:

- **IT IS ESSENTIAL TO KEEP A RECORD OF OBSERVATIONS MADE REGARDING OPERATING CONDITION, ANY TEST PARAMETERS & TEST RESULTS OBTAINED.**

- **IN CASE OF ANY ABNORMALITY OCCURRING DURING SERVICE, ADVICE FROM THE SUPPLIERS SHOULD BE OBTAINED, GIVING THEM NAME-PLATE PARTICULARS AND COMPLETE DETAILS AS TO THE NATURE & THE EXTENT OF OCCURRENCE.**

Customers are hereby advised to contact us by letter/ fax/ e-mail / phone incase of any doubt before doing something wrong at the time of installation / commissioning to avoid any complication damage to your transformer.

We values our customer feed back and can help us serve you better.

6.17 MAINTENANCE SCHEDULE

Maintenance Schedule for the attention required under average condition is given below;

Sl. No.	*Frequency of Inspection*	*Items to be Inspected*	*Inspection Notes*	*Action requited for unsatisfactory conditions*
01	**Hourly / Daily**	Ambient Temp.	For reference	-
02	- do -	Oil / Winding Temperature	Check that temp rise is within the limit	For any abnormal temp. rise trip, investigate the cause.
03	- do -	Load Voltage & Current	Check against the rated figures	For any abnormal tripping, investigate the cause.
04	**Weekly / as convenient**	Dehydrating Breather	Check desiccant colour & oil seal	Replace the desiccant or make up the oil, as required.
05	- do -	Oil level in Main Tank	Check the level against oil temp.	If low, investigate the oil leak & top up with dry oil.
06	- do -	Buchholz Relay	Check gas collection	Take suitable action to prevent any potential fault.
07	- do -	Gasket Joints & Radiators	Check for tightness & oil leakage	Arrange for replacement / repair as required.
08	- do -	Explosion Vent / Pr. Relief Device	Check for proper sealing / indicator	Rectify / Investigate the damage / malfunction.
09	**Quarterly / as convenient**	Oil	Check for dielectric strength / sludge	Take suitable action to restore quality of oil.
10	- do -	Cable Box / Trmnl. Bushings	Check for tightness / dirt / damage	Clean thoroughly, if needed, take remedial measures.
11	- do -	OCTC	Check for smooth operation	If required, replace oil / worn-out parts.
12	**Half Yearly / as convenient**	Earthing Terminals	Check tightness & Earth Resistance	Take remedial action if earth resistance is high
13	- do -	Accessories / Auxiliary Circuits	Check operation & switching contacts.	Clean the components, if necessary, replace the item.
14	**Yearly / as convenient**	Buchholz relay / Surge relay	Mechanical inspection	Check floats, contact switches operation
15	- do -	Insulation Resistance	Check IR values	If low investigate & take action to restore insulation
16	- do -	Fastening Bolts / Screws / Clamps	Check for tightness	Replace the defective fasteners
17	- do -	Paint-work	Check for peelings / rusting/ damage	Repaint, as required.
18	**Two Years / as convenient**	Temperature indicator	Check operation & switching contacts.	Clean the components, if necessary, replace the item.
19	- do -	Oil Gauge.	Check operation & switching contacts.	Clean the components, if necessary, replace the item.
20	- do -	Oil conservator	Internal inspection	Clean if necessary
21	**3-5 Years / as convenient**	Overall paint-work	Check for deterioration	Consider full repaint to original specification
22	- do -	OCTC switches	Check for arcing / welding / wearing	Replace / Repair defective components as necessary
23	- do -	Core & Windings	Check for tightness / cleanliness	Replace / Repair defective components as necessary